

WHAT WE CLAIM ARE:

1. A method of manufacturing a semiconductor device, comprising the steps of:

(a) preparing a semiconductor substrate having first and second regions of a first conductivity type defined in a principal surface area of the

5 semiconductor substrate;

(b) forming first and second gate electrodes in respective partial areas of said first and second regions;

(c) by using the second gate electrodes as a mask, implanting impurities of a second conductivity type opposite to said first conductivity type
10 into each surface layer in said second regions and thereafter executing a first activation process to form first impurity diffusion regions;

(d) forming first spacer films on side surfaces of said first and second gate electrodes;

(e) by using said first and second gate electrodes and said first
15 spacer films as a mask, implanting impurities of said second conductivity type into surface layers in said first and second regions and thereafter executing a second activation process to form second impurity diffusion regions;

(f) removing said first spacer films; and

(g) by using said first gate electrodes as a mask, implanting
20 impurities of said second conductivity type into each surface layer in said first regions and thereafter executing a third activation process to form third impurity diffusion regions, wherein said third activation process is executed so that the gradient of an impurity concentration distribution in a p-n junction formed by said third impurity diffusion regions becomes steeper than the gradient of an impurity
25 concentration distribution in a p-n junction formed by said first impurity diffusion regions formed by said first activation process.

2. A method of manufacturing a semiconductor device according to claim 1,
wherein said step (c) is executed after said step (f).
- 5 3. A method of manufacturing a semiconductor device according to claim 1,
wherein each of said first to third activation processes includes a thermal
treatment at a temperature at least equal to 750 °C.
4. A method of manufacturing a semiconductor device according to claim 1,
10 further comprising steps of:
- (h) forming second spacer films on the side surfaces of said first
and second gate electrodes; and
- (i) by using said second spacer films as a mask, forming a metal
silicide layer on said first and second gate electrodes and on said second
15 impurity diffusion regions.
5. A method of manufacturing a semiconductor device according to claim 1,
wherein said third activation process is a laser thermal process.
- 20 6. A method of manufacturing a semiconductor device according to claim 5,
wherein said process (g) comprises a step of forming an absorption layer which
improves an absorption efficiency of laser radiated to said semiconductor
substrate, a step of implanting impurity ions of the second conductivity type into
at least said first regions by using said first gate electrodes as a mask, and a step
25 of executing a thermal treatment by said laser thermal process.

7. A method of manufacturing a semiconductor device according to claim 1,
wherein at least the first gate electrodes are dummy gate electrodes, and the
method further comprises, after said step (g), a step of forming an insulating film
over said semiconductor substrate, said insulating film having etching
5 characteristics different from material of said dummy gate electrode, and
planarizing a surface of said insulating film to expose upper surfaces of said
dummy gate electrodes, a step of selectively removing said dummy gate
electrodes with respect to said insulating film, and a step of burying conductive
material in spaces from which said dummy gate electrodes were removed.

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8. A method of manufacturing a semiconductor device according to claim 1,
wherein the shortest gate length among said first gate electrodes is shorter than
the shortest gate length among said second gate electrodes.

15 9. A method of manufacturing a semiconductor device according to claim 1,
wherein said first and second activation processes are executed at the same
time.

10. A method of manufacturing a semiconductor device, comprising the steps
20 of:

(a) preparing a semiconductor substrate having first and second
regions of a first conductivity type defined in a principal surface area of the
semiconductor substrate;

(b) forming at least first gate electrodes in a partial area of the first
25 region;

(c) implanting impurities of a second conductivity type opposite to

said first conductivity type into each surface layer of said second regions, and thereafter executing a first activation process to form first impurity diffusion regions;

(d) forming first spacer films on side surfaces of said first gate electrodes;

(e) by using said first gate electrodes and said first spacer films as a mask, implanting impurities of said second conductivity type into each surface layer of said first regions, and thereafter executing a second activation process to form second impurity diffusion regions;

(f) removing said first spacer films; and

(g) by using said first gate electrodes as a mask, implanting impurities of said second conductivity type into each surface layer in said first regions and thereafter executing a third activation process to form third impurity diffusion regions, wherein said third activation process is executed so that the gradient of an impurity concentration distribution in a p-n junction formed by the third impurity diffusion regions becomes steeper than the gradient of an impurity concentration distribution in a p-n junction formed by said first impurity diffusion regions formed by said first activation process.

11. A method of manufacturing a semiconductor device according to claim 10, wherein each of said first to third activation processes includes a thermal treatment at a temperature at least equal to 750 °C.

12. A method of manufacturing a semiconductor device according to claim 10, wherein said third activation process is a laser thermal process.

13. A method of manufacturing a semiconductor device according to claim 10, wherein the shortest gate length among said first gate electrodes is shorter than the shortest gate length among said second gate electrodes.

5 14. A method of manufacturing a semiconductor device, comprising the steps of:

(a) preparing a semiconductor substrate having first and second regions of a first conductivity type defined in a principal surface area of the semiconductor substrate;

10 (b) forming at least first gate electrodes in a partial area of said first region;

(c) forming first spacer films on side surfaces of said first gate electrodes;

(d) by using said first gate electrodes and first spacer films as a
15 mask, implanting impurities of a second conductivity type opposite to said first conductivity type into surface layer of said first region, and thereafter executing first activation process to form first impurity diffusion regions;

(e) implanting impurities of the second conductivity type into surface layer of the second regions, and thereafter executing a second activation
20 process to form second impurity diffusion regions;

(f) removing said first spacer films; and

(g) by using said first gate electrodes as a mask, implanting impurities of said second conductivity type into surface layer in said first regions and thereafter executing a third activation process to form third impurity diffusion
25 regions, wherein said third activation process is executed so that the gradient of an impurity concentration distribution in a p-n junction formed by said third

impurity diffusion regions becomes steeper than the gradient of an impurity concentration distribution in a p-n junction formed by said second impurity diffusion regions formed by said second activation process.

5 15. A method of manufacturing a semiconductor device according to claim 14, wherein each of said first to third activation processes includes a thermal treatment at a temperature at least equal to 750 °C.

16. A method of manufacturing a semiconductor device according to claim 14,
10 wherein said third activation process is a laser thermal process.

17. A method of manufacturing a semiconductor device according to claim 14, wherein the shortest gate length among said first gate electrodes is shorter than the shortest gate length among said second gate electrodes.

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18. A semiconductor device comprising:

a semiconductor substrate having first and second regions of a first conductivity type defined in a principal surface area of the semiconductor substrate;

20 first and second gate electrodes formed in said first and second regions;

first SDE regions formed in surface layer on both sides of said second gate electrode and doped with impurities of a second conductivity type opposite to said first conductivity type;

25 second SDE regions formed in surface layer on both sides of said first gate electrode wherein the gradient of an impurity concentration distribution

in a p-n junction formed by said second SDE regions is steeper than the gradient of an impurity concentration distribution in a p-n junction formed by said first SDE regions; and

source/drain regions formed on both sides of the first and second
5 SDE regions wherein an impurity concentration distribution is the same in both p-n junctions formed by said source/drain regions in the first and second regions.

19. A semiconductor device according to claim 18, wherein a gate length of
said first gate electrode is shorter than a gate length of said second gate
10 electrodes.

20. A semiconductor device according to claim 18, further comprising a pocket
implantation region of said first conductivity type at least in an area under each of
said first SDE regions.

15 21. A method of manufacturing a semiconductor device, comprising the steps
of:

(a) preparing a semiconductor substrate having a first region of a
first conductivity type and a second region filled with an element separation
20 insulating film, respectively defined in a principal surface area of the
semiconductor substrate;

(b) forming a gate electrode at least in a partial area of the first
region and a resistor layer made of material same as the gate electrode at least
in a partial area of the second region;

25 (c) forming first and second spacer films on side walls of the gate
electrode and the resistor layer;

(d) implanting impurities of a second conductivity type opposite to the first conductivity type into a surface layer in the first region by using the gate electrode and the first spacer films as a mask, and also into the resistor layer, and then executing a first activation process to thereby form first impurity diffusion regions in the surface layer in the first region and lower a resistance of the resistor layer;

(e) removing the first and second spacer films; and

(f) implanting impurities of the second conductivity type into the surface layer in the first region by using the gate electrode as a mask, and then
10 executing a second activation process to thereby form second impurity diffusion regions, wherein the second activation process is performed under a condition that a gradient of an impurity concentration distribution in a p-n junction in each of the second impurity diffusion regions becomes sharper than a gradient of an impurity concentration distribution in a p-n junction in each of the first impurity
15 diffusion regions formed by the first activation process.

22. A method of manufacturing a semiconductor device according to claim 21, further comprising the steps of:

(g) forming a protective insulating film over the semiconductor
20 substrate, the protective insulating film covering the gate electrode and the resistor layer;

(h) forming a mask covering the second region and thereafter anisotropically etching the protective insulating film to leave the protective insulating film on the side walls of the gate electrodes and in the second region;

25 (i) depositing a metal layer over the semiconductor substrate and executing a heat treatment to thereby form a metal silicide layer on an upper

surface of the gate electrode; and

(j) selectively removing the unreacted metal layer on the protective insulating film.

5 23. A method of manufacturing a semiconductor device, comprising the steps of:

(a) preparing a semiconductor substrate having first and second regions of a first conductivity type and a third region filled with an element separation insulating film, respectively defined in a principal surface area of the

10 semiconductor substrate;

(b) forming first and second gate electrodes at least in partial areas of the first and second regions and a resistor layer made of material same as the first and second gate electrodes at least in a partial area of the third region;

(c) implanting impurities of a second conductivity type opposite to
15 the first conductivity type into the second region by using the second gate electrode as a mask and thereafter executing a first activation process to thereby form first impurity diffusion regions in a surface layer in the second region;

(d) forming first spacer films on side walls of the first and second gate electrodes and second spacer films on side walls of the resistor layer;

20 (e) implanting impurities of the second conductivity type at least in surface layers of the first and second regions by using the first and second gate electrodes and the first spacer films as a mask, and also into the resistor layer, and thereafter executing a second activation process to thereby form second impurity diffusion regions at least in the surface layer of the first or second region

25 and lower a resistance of the resistor layer;

(f) removing the first and second spacer films; and

(g) implanting impurities of the second conductivity type into the surface layer in the first region by using the first gate electrode as a mask and thereafter executing a third activation process to thereby form third impurity diffusion regions, wherein the third activation process is performed under a condition that a gradient of an impurity concentration distribution in a p-n junction in each of the third impurity diffusion regions becomes sharper than a gradient of an impurity concentration distribution in a p-n junction in each of the first impurity diffusion regions formed by the first activation process.

24. A method of manufacturing a semiconductor device according to claim 23, further comprising the steps of:

(h) forming a protective insulating film over the semiconductor substrate, the protective insulating film covering the first and second gate electrodes and the resistor layer;

(i) forming a mask covering the third region and partial areas in the first impurity diffusion regions and thereafter anisotropically etching the protective insulating film to leave the protective insulating film on the side walls of the first and second gate electrodes, in the second region, and in said partial areas;

(j) depositing a metal layer over the semiconductor substrate and executing a heat treatment to thereby form a metal silicide layer on an upper surface of the first impurity diffusion regions excepting said partial area and on upper surfaces of the first and second gate electrodes; and

(j) selectively removing the unreacted metal layer on the protective insulating film.